Mediclinic Rooftop PV Projects: Performance Report January 2023

Prepared for:

Moshesh Partners

Reference No:

HAR\_215\_Moshesh Mediclinic Monthly Performance January 2023 Report.v1

July 2023

Document Control

|  |  |  |  |
| --- | --- | --- | --- |
| Responsible for | Name | Date | Signature |
| Content | Mutali Nepfumbada | 03 March 2023 |  |
| Checked | Justin Wimbush  Chanda Nxumalo | 07 March 2023 |  |
| Approved | Adam Terry | 20 March 2023 |  |
| Copyright: | Commercial in Confidence | Document Reference: | HAR\_215\_Moshesh Mediclinic Monthly Performance January 2023 Report.v1 |
| Signatures in this approval box have checked this document in line with quality procedures requirements.  This document has been prepared by Harmattan with all reasonable skill and care. The document contains information from sources and data which we believe to be reliable, but we have not confirmed that reliability and make no representation as to their accuracy or completeness.  The document is confidential to the Client and Harmattan accepts no responsibility to any third party to whom information in this proposal may be disclosed. No part of this document may be reproduced without the prior written approval of Harmattan. | | | |

Table of Contents

[1. Introduction 7](#_Toc130236196)

[1.1. Scope of Work 7](#_Toc130236197)

[1.2. Site Visits 7](#_Toc130236198)

[1.3. Report Layout and Risk Assessment Scale 7](#_Toc130236199)

[2. Executive Summary 8](#_Toc130236200)

[2.1. Portfolio Overview 8](#_Toc130236201)

[2.2. Performance Summary 9](#_Toc130236202)

[2.2.1. Moshesh Mediclinic Vergelegen Solar PV 9](#_Toc130236203)

[2.2.2. Moshesh Mediclinic Durbanville Solar PV 9](#_Toc130236204)

[2.2.3. Moshesh Mediclinic Midstream Solar PV 9](#_Toc130236205)

[2.2.4. Moshesh Mediclinic Hermanus Solar PV 9](#_Toc130236206)

[2.2.5. Moshesh Mediclinic Highveld Solar PV 9](#_Toc130236207)

[2.2.6. Moshesh Mediclinic Tzaneen Solar PV 9](#_Toc130236208)

[2.3. Key Risks, Recommendations & Actions 10](#_Toc130236209)

[2.4. O&M Contract 12](#_Toc130236210)

[2.5. EPC Contract 12](#_Toc130236211)

[3. Portfolio Revenue 13](#_Toc130236212)

[3.1. PPA Rates 13](#_Toc130236213)

[3.2. Revenue Year to Date 13](#_Toc130236214)

[4. Technical Portfolio Overview 15](#_Toc130236215)

[4.1. Data Analysed 15](#_Toc130236216)

[5. Highveld Technical Performance 16](#_Toc130236217)

[5.1. System Design 16](#_Toc130236218)

[5.2. Irradiation vs Forecast 16](#_Toc130236219)

[5.3. Availability vs Forecast 16](#_Toc130236220)

[5.4. Performance Ratio vs Forecast 17](#_Toc130236221)

[5.5. Production vs Forecast 17](#_Toc130236222)

[6. Durbanville Technical Performance 18](#_Toc130236223)

[6.1. System Design 18](#_Toc130236224)

[6.2. Irradiation vs Forecast 18](#_Toc130236225)

[6.3. Availability vs Forecast 18](#_Toc130236226)

[6.4. Performance Ratio vs Forecast 19](#_Toc130236227)

[6.5. Production vs Forecast 19](#_Toc130236228)

[7. Midstream Technical Performance 20](#_Toc130236229)

[7.1. System Design 20](#_Toc130236230)

[7.2. Irradiation vs Forecast 20](#_Toc130236231)

[7.3. Availability Vs Forecast 20](#_Toc130236232)

[7.4. Performance Ratio Vs Forecast 21](#_Toc130236233)

[7.5. Production vs Forecast 21](#_Toc130236234)

[8. Hermanus Technical Performance 22](#_Toc130236235)

[8.1. System Design 22](#_Toc130236236)

[8.2. Irradiation Vs Forecast 22](#_Toc130236237)

[8.3. Availability Vs Forecast 22](#_Toc130236238)

[8.4. Performance Ratio vs Forecast 23](#_Toc130236239)

[8.5. Production Vs Forecast 23](#_Toc130236240)

[9. Vergelegen Technical Performance 24](#_Toc130236241)

[9.1. System Design 24](#_Toc130236242)

[9.2. Irradiation Vs Forecast 24](#_Toc130236243)

[9.3. Availability Vs Forecast 25](#_Toc130236244)

[9.4. Performance Ratio Vs Forecast 25](#_Toc130236245)

[9.5. Production Vs Forecast 25](#_Toc130236246)

[10. Tzaneen Technical Performance 27](#_Toc130236247)

[10.1. System Design 27](#_Toc130236248)

[10.2. Irradiation Vs Forecast 27](#_Toc130236249)

[10.3. Availability vs Forecast 27](#_Toc130236250)

[10.4. Performance Ratio Vs Forecast 28](#_Toc130236251)

[10.5. Production Vs Forecast 28](#_Toc130236252)

[11. Events 29](#_Toc130236253)

[11.1. Health and Safety 29](#_Toc130236254)

[11.2. Scheduled Maintenance 29](#_Toc130236255)

[11.3. Unscheduled Maintenance 29](#_Toc130236256)

[11.4. Spare Parts 29](#_Toc130236257)

[12. Documents Reviewed 30](#_Toc130236258)

List of Figure

[Figure 2‑1: Project Locations 8](#_Toc130236259)

[Figure 4‑1: Revenue to Date Year to Date 13](#_Toc130236260)

List of Table

[Table 1‑1: Risk Definitions Key 7](#_Toc130236160)

[Table 2‑1: Project Overview 8](#_Toc130236161)

[Table 3‑1: Liquidated damages 12](#_Toc130236162)

[Table 4‑1: PPA Rates 13](#_Toc130236163)

[Table 4‑2: Project Revenue Year to Date Overview 14](#_Toc130236164)

[Table 6‑1: Highveld Project Overview 16](#_Toc130236165)

[Table 6‑2: Highveld Irradiation and Forecast 16](#_Toc130236166)

[Table 6‑3: Highveld Availability and Forecast 16](#_Toc130236167)

[Table 6‑4: Highveld PR and Forecast 17](#_Toc130236168)

[Table 6‑5: Hermanus Production and Forecast 17](#_Toc130236169)

[Table 7‑1: Highveld Project Overview 18](#_Toc130236170)

[Table 7‑2: Durbanville Irradiation and Forecast 18](#_Toc130236171)

[Table 7‑3: Durbanville Availability and Guaranteed 18](#_Toc130236172)

[Table 7‑4: Durbanville PR and Forecast 19](#_Toc130236173)

[Table 7‑5: Durbanville Production and Forecast 19](#_Toc130236174)

[Table 8‑1:Midstream Project Overview 20](#_Toc130236175)

[Table 8‑2: Midstream Irradiation and Forecast 20](#_Toc130236176)

[Table 8‑3: Midstream Availability and Guaranteed 20](#_Toc130236177)

[Table 8‑4: Midstream PR and Forecast 21](#_Toc130236178)

[Table 8‑5: Midstream Production and Forecast 21](#_Toc130236179)

[Table 9‑1: Hermanus Project Overview 22](#_Toc130236180)

[Table 9‑2: Hermanus Irradiation and Forecast. 22](#_Toc130236181)

[Table 9‑3: Hermanus Availability and Forecast 22](#_Toc130236182)

[Table 9‑4: Hermanus PR and Forecast 23](#_Toc130236183)

[Table 9‑5: Hermanus Production and Forecast 23](#_Toc130236184)

[Table 10‑1: Vergelegen Project Overview 24](#_Toc130236185)

[Table 10‑2: Vergelegen Irradiation and forecast. 24](#_Toc130236186)

[Table 10‑3: Vergelegen Availability and Guaranteed 25](#_Toc130236187)

[Table 10‑4: Vergelegen PR and Forecast 25](#_Toc130236188)

[Table 10‑5: Vergelegen Production and Forecast 25](#_Toc130236189)

[Table 11‑1: Tzaneen Project Overview 27](#_Toc130236190)

[Table 11‑2: Tzaneen Irradiation and Forecast. 27](#_Toc130236191)

[Table 11‑3:Tzaneen Availability and Guaranteed 27](#_Toc130236192)

[Table 11‑4: Tzaneen PR and Forecast 28](#_Toc130236193)

[Table 11‑5: Tzaneen Production and Forecast 28](#_Toc130236194)

[Table 13‑1: Document Reviewed 30](#_Toc130236195)

Abbreviations

|  |  |
| --- | --- |
| COD | Commercial Operating Date |
| HSE | Health and Safety and Environment |
| kWh | Kilo Watt Hour |
| OPEX | Operating expenses |
| PPA | Power Purchase Agreement |
| PR | Performance ratio |
| SCADA | Supervisory control and data acquisition |
| YTD | Year-to-date |

Glossary of Terms

|  |  |
| --- | --- |
| Actual Production | Production produced in kWh |
| Predicted Production | The forecasted P50 production in kWh |
| PR | Actual production divided by weather adjusted production in % |
| Weather Adjusted Predicted | Predicted production adjusted for actual weather in kWh |

# Introduction

Harmattan Renewables (“Harmattan”) has been appointed by Moshesh Partners (the “Client”) to provide asset management support for its rooftop PV assets at six Mediclinic sites across South Africa (each a “Project,” together the “Portfolio”). The Projects were installed by ACES Africa (“ACES”) who are now acting as the O&M contractor (the “Operator”).

## Scope of Work

The scope of work is fully described in Harmattan proposal “*HAR\_P215\_MOSHESH\_MediclinicAssetManagement \_v2”*, dated 15 July 2022”.

## Site Visits

No site visits were performed in January 2023. We are planning a site visit to Tzaneen on 30 March 2023.

## Report Layout and Risk Assessment Scale

Key findings and recommendations to the Client are highlighted in section 2. Risks are colour coded and include a narrative of the overall findings. A detailed summary of the documents reviewed is included in section 9. Where possible, Harmattan has confirmed if review items are consistent with market norms / standards and across all Project documentation. Where Harmattan identified an omission, error, inconsistency, or deviation from our expectations, the issue is flagged, analysed, and assigned a risk rating as outlined in Table 1‑1.

For all items, where an issue is identified, a risk category and colour code are allocated. Categorisation is achieved by making a qualitative assessment of the probability of the occurrence of the issue and the severity of the impact of the issue and allocating a tag Critical (C) / High (H) / Medium (M) / Low (L) / Negligible (N) and associated colour code to each issue (together with a brief explanation of why the tags were chosen). These tags are then multiplied in a range of combinations to yield a qualitative risk categorisation (see graphic below). This categorisation of risk allows for the prioritisation of the issues originally identified and brings a degree of focus to the subsequent mitigation process. If no risk is present / relevant, then the categorisation is summarised as 'Not Applicable' (N/A). Harmattan highlights that a simple, non-numerical, approach has been adopted to maintain the simplicity and functionality of the method and to avoid unproductive debates around the calibration of the categorisation components.

|  |  |  |
| --- | --- | --- |
| Key | Definition | Description |
| C | Critical | Risk of critical negative influence on project/investment outcome |
| H | High | Risk of high negative influence on project/investment outcome |
| M | Medium | Risk of medium negative influence on project/investment outcome. |
| L | Low | Risk of low negative influence on project/investment outcome. |
| N | Negligible | Risk of negligible negative influence on project/investment outcome. |
| N/A | Not Applicable | No risk present/relevant. |
| TBC | Awaiting  Information | Additional information required to enable Harmattan to opine on the risk. |

Table 1‑1: Risk Definitions Key

# Executive Summary

## Portfolio Overview

The following map shows the location of Moshesh Rooftop PV Portfolio operating sites. The sites are in the Gauteng and Western Cape Provinces of South Africa.

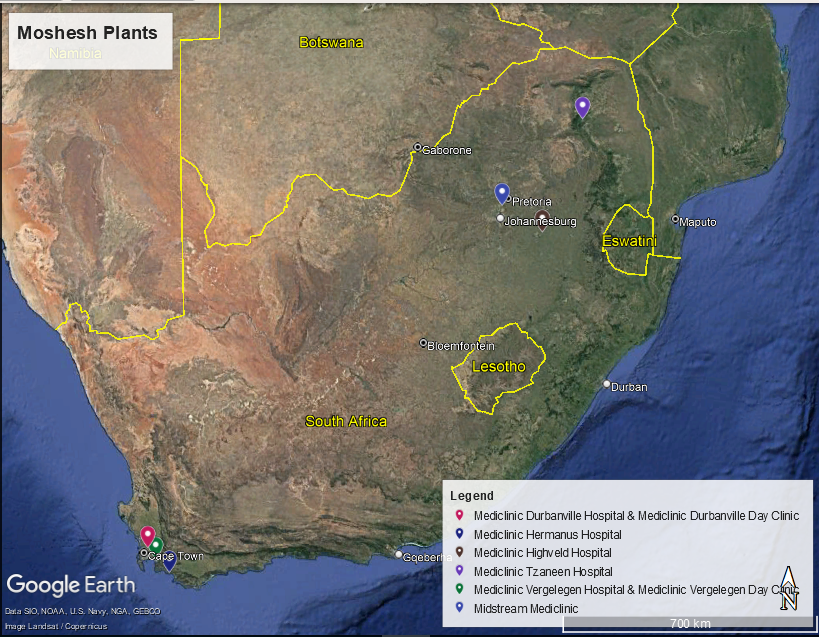


Figure 2‑1: Project Locations

|  |  |  |  |
| --- | --- | --- | --- |
| Name | COD (Commercial Operation Date) | Design Capacity DC/AC (kW) | Installed  Capacity DC/AC (kW) |
| Moshesh Mediclinic Durbanville Solar PV (“Durbanville”) | 11 November 2021 | 704.6 / 650 | 705.7 / 650 |
| Moshesh Mediclinic Hermanus Solar PV (“Hermanus”) | 10 March 2022 | 211.7 / 200 | 211.7 / 220 |
| Moshesh Mediclinic Highveld Solar PV (“Highveld”) | 30 March 2022 | 263 / 250 | 258.9 / 250 |
| Moshesh Mediclinic Midstream Solar PV (“Midstream”) | 27 October 2021 | 227.9 / 200 | 227.9 / 220 |
| Moshesh Mediclinic Vergelegen Solar PV (“Vergelegen”) | 28 October 2021 | 697.1 / 650 | 689.6 / 650 |
| Moshesh Mediclinic Tzaneen Solar PV (“Tzaneen”) | 11 October 2022 | 405/400 | 405/350 |

Table 2‑1: Project Overview

## Performance Summary

The following section summarises the performance of the sites in Q1 2023.

### Moshesh Mediclinic Vergelegen Solar PV

* Production 119,980 kWh with a variance of -25.18 % below the P50 forecast.
* Irradiation is 268 kWh/m2 with a variance of -8.04 % below P50 forecast.
* Availability is 52% with a variance of -47.81% above the warranted availability.
* PR is 78% with a variance of -12.95% below warranted PR.
* Revenue is R89,918 with a variance of -25.18% below forecast.
  + 1. Moshesh Mediclinic Durbanville Solar PV
* Production 115,763 kWh with a variance of -44.18 % below the P50 forecast.
* Irradiation is 277 kWh/m2 with a variance of -27.54 % below P50 forecast.
* Availability is 81% with a variance of -18.68% above the warranted availability.
* PR is 65% with a variance of -28.23% below warranted PR.
* Revenue is R85,600 with a variance of -44.18% below forecast.
  + 1. Moshesh Mediclinic Midstream Solar PV
* Production 61,767 kWh with a variance of -18.01 % below the P50 forecast.
* Irradiation is 398 kWh/m2 with a variance of -4.80 % below P50 forecast.
* Availability is 77% with a variance of -22.02% above the warranted availability.
* PR is 93% with a variance of 3.84% below warranted PR.
* Revenue is R50,756 with a variance of -18.01% below forecast.
  + 1. Moshesh Mediclinic Hermanus Solar PV
* Production 29,402 kWh with a variance of -48.95 % below the P50 forecast.
* Irradiation is 295 kWh/m2 with a variance of -8.76 % below P50 forecast.
* Availability is 56% with a variance of -43.61% above the warranted availability.
* PR is 55% with a variance of -39.43% below warranted PR.
* Revenue is R28,473with a variance of -48.95% below forecast.
  + 1. Moshesh Mediclinic Highveld Solar PV
* Production 67,219 kWh with a variance of -26.36 % below the P50 forecast.
* Irradiation is 398 kWh/m2 with a variance of -12.14 % below P50 forecast.
* Availability is 70% with a variance of -29.00% above the warranted availability.
* PR is 83% with a variance of -7.93% below warranted PR.
* Revenue is R53,991 with a variance of -26.36% below forecast.
  + 1. Moshesh Mediclinic Tzaneen Solar PV
* Production 87,282 kWh with a variance of -41.43 % below the P50 forecast.
* Irradiation is 389 kWh/m2 with a variance of -7.32 % below P50 forecast.
* Availability is 0% with a variance of -100.00% above the warranted availability.
* PR is 67% with a variance of -25.87% below warranted PR.
* Revenue is R28,705 with a variance of -32.01 % below forecast.

## Key Risks, Recommendations & Actions

The following table describe the risk identified in January 2023.

|  |  |  |  |
| --- | --- | --- | --- |
| Key Risks | Description | Risk Rating | Recommendations |
| Portfolio Key risk | Harmattan has identified the following portfolio risks:   * All the plants, except for Vergelegen, have performed below forecast due to loadshedding. The plants have experienced low availability because the inverters are grid tied, which results in loss of production during grid outages. We note that due to the increase in load shedding the plants will continue to underperform going forward. * We have reviewed the SCADA systems and noted that the irradiation data was not recorded due to logging errors, resulting in large data gaps. The Operator has opted to use google studio to record the data rather than the use of specialist software. * No annual plan was provided by the Operator with Scheduled maintenance activities. | H | We recommend that the Client identify any financial risk and adjust their financial model to account for the load shedding in 2023 as load shedding will persist.  Harmattan further also recommends that the Operator resolve the SCADA data handling issue and use a central monitoring system for all the plants.  We also recommend that the Operator install UPS systems in each plant control system to enable plant data to continue to be supplied to the central SCADA during grid outages.    We recommend that the Operator provide an annual maintenance plan with specific dates. |
| EPC Contract | Harmattan has performed LD calculations for the Midstream, Vergelegen, and Durbanville plants. We were provided with Solcast irradiation data in the form of an Excel spread sheet for the 12-months of production. This approach was taken as the irradiation data extracted from the SCADA contained gaps due to network communication errors during load shedding events.  Harmattan performed the initial calculation based on Annexures 5 and 7 of the EPC contracts and we included the deemed energy provided by the Operator.  The calculation resulted in LD of **R 193,134.16** for the three projects assessed.  The Operator then performed a review of the calculation and then included some additional losses based on a load shedding schedule for the 2022 years of production.  The calculation with the additional losses resulted in reduction of the LDs payable to **R 183,271.44**  Harmattan reviewed the Operator’s calculation note their load shedding losses cannot be verified on the SCADA system as the SCADA does not distinguish between grid fault and normal system faults. | H | While the extent of losses due to load shedding claimed by ACES appear reasonable given knowledge of the loadshedding taking place over the past year, Harmattan cannot unfortunately verify the reduction in LDs claimed.  Harmattan recommends:   * The SCADA systems installed are upgraded to the following.   + Add a module to the SCADA that can allow load shedding downtime to be logged or replace the system with the SCADA that would allow losses due to load shedding to be verified.   + Irradiation measurement and recording to be improved. We have moted that the irradiation measured by the onsite pyranometer at Hermanus had fewer data gaps which suggested that a UPS was installed We recommend installing UPS on all site to reduce data loss recorded from either satellite or onsite pyranometer.   + Include an automated calculation and recording of P/R. * On the LD calculation the Operator:   + Use Load Shedding Schedule Data: Instead of relying solely on nationwide load shedding days, it may be helpful to obtain load shedding schedules for the specific areas where the sites are located. This can provide more accurate information about when load shedding is expected to occur and help to better estimate the impact on the sites.   + Consider Inverter Start-up Time: To account for the time, it takes for the inverters to start up, it may be helpful to add a buffer period before and after the estimated load shedding time. This can ensure that the estimated impact on the sites is more accurate.   + Improve Automation as the process is currently very manual. Implementing more automation can help to streamline the process and reduce errors. This could include talking to the SCADA manufacture on improving the system. |
| Tzaneen technical | The SCADA system is not recording any availability data. | H | We recommend that the Operator check the availability module on the SCADA for this project for correct functionality. |
| Midstream technical | We have noted inconsistencies between the actual Performance Ratio (PR) and the forecast production values. This suggests that there may be an issue with the calculation of the PR, as it is not producing accurate results. | H | We recommend that the Operator clarify the formula they are using to calculate the PR as the formula is not defined under the contract, especially if it is being done manually rather than through the SCADA system. They should also ensure that the calculation method is accurate and up to date with the current industry standards. |

Table 2‑2: Key Risk Contracts

## O&M Contract

The O&M contract between Moshesh and ACES Africa (Operator) was executed in December 2022.

## EPC Contract

Harmattan has calculated the LDs under the EPC contract for Durbanville, Vergelegen and Midstream. Harmattan was provided with 12-months of satellite data in Excel format, as the SCADA data contained gaps. The results of the calculation are stated in Table 2‑2.

|  |  |  |
| --- | --- | --- |
| Plant | Harmattan Liquidated Damages Payable | ACES Liquidated Damages Payable |
| Durbanville | R 89,358.91 | R 84,541.93 |
| Midstream | R 16,052.49 | R 14,162.61 |
| Vergelegen | R 87,722.76 | R 84,566.89 |
| Total | R 193,134.16 | R 183,271.44 |

Table 2‑2: Liquidated damages

Table 2‑2. shows that the Operator has included additional deemed losses which Harmattan cannot verify as the SCADA is unable to distinguish grid maintenance works, Mediclinic interference, load shedding and normal faults. This reduces their LD total to R183,271.44 compared to the Harmattan total of R193,134.16.

The additional Deemed losses by the Operator were estimated by calculating the average kW during the time of load shedding and multiplying it by the amount of time the site was down for (adjusted for weather data).

However, as noted by the Operator, load shedding schedules can vary, and the inverters may take some time to start up. This could affect the accuracy of the estimates. Additionally, the Operator mentioned that they are "blind" to whether the site had load shedding or not and that the process is currently very manual.

Harmattan is unable to verify the Operator’s losses from the SCADA system as it does not distinguish normal fault, grid fault and load shedding. Additionally, the SCADA system has not being used to store irradiation data or PR calculation. We understand this is because data is lost during load shedding due to network connectivity issues.

Harmattan considers the SCADA systems not suitable for correctly monitoring the Projects. We recommend they be upgraded to include:

* Add a module to the SCADA that can allow load shedding downtime to be logged or replace the system with the SCADA that would allow losses due to load shedding to be verified.
* Irradiation measurement and recording to be improved. We have moted that the irradiation measured by the onsite pyranometer at Hermanus had fewer data gaps which suggested that a UPS was installed We recommend installing UPS on all site to reduce data loss recorded from either satellite or onsite pyranometer.
* Include an automated calculation and recording of P/R.

On the LD calculation we recommend that the Operator:

* Use Load Shedding Schedule Data: Instead of relying solely on nationwide load shedding days, it may be helpful to obtain load shedding schedules for the specific areas where the sites are located. This can provide more accurate information about when load shedding is expected to occur and help to better estimate the impact on the sites.
* Consider Inverter Start-up Time: To account for the time, it takes for the inverters to start up, it may be helpful to add a buffer period before and after the estimated load shedding time. This can ensure that the estimated impact on the sites is more accurate.
* Improve Automation: As noted by the Operator, the process is currently very manual. Implementing more automation can help to streamline the process and reduce errors. This could include talking to the SCADA manufacture on improving the system.

# Portfolio Revenue

## PPA Rates

Revenues are based on actual production and the rate agreed upon between each Mediclinic site and Moshesh under the Power Purchase Agreements (PPA) as described in Table 3-1 below.

|  |  |  |
| --- | --- | --- |
| Plant | PPA Rate (ZAR/kWh) | Applicable Year |
| Durbanville | 0.6423 | 11 November 2021 - 10 November 2022 |
| Vergelegen | 0.6517 | 28 October 2021 - 27 October 2022 |
| Highveld | 0.6589 | 30 March 2022 -29 March 2023 |
| Midstream | 0.7145 | 27 October 2021 - 26 October 2022 |
| Hermanus | 0.7944 | 10 March 2022 - 9 March 2023 |
| Tzaneen | 0.7934 | 11 October 2023 - 10 October2023 |

Table 3‑1: PPA Rates

The PPA rates increase by 6% every 12 months from COD. Vergelegen, Midstream and Durbanville have increased by 6% from October 2022. Hermanus and Highveld will increase in April 2023 and Tzaneen in October 2023.

Forecast revenues are based on the P50 Helioscope simulation, which is loaded into the SCADA and allows calculation of degradation. The simulations were performed during pre-construction and have not been adjusted to reflect actual irradiation or the installed capacity.

Actual revenue is based upon production as recorded by the SCADA and the PPA rates.

## Revenue Year to Date

The following graph shows the year-to-date Project’s energy sales in South African Rand (ZAR).

Figure 3‑1: Revenue to Date Year to Date

|  |  |  |  |
| --- | --- | --- | --- |
| **Revenue (ZAR)** | | | |
| **Plants** | **Actual** | **Forecast** | **Delta (%)** |
| Durbanville | 85,600 | 153,341 | -44.18 |
| Vergelegen | 89,918 | 120,178 | -25.18 |
| Highveld | 53,991 | 73,319 | -26.36 |
| Midstream | 50,756 | 61,904 | -18.01 |
| Hermanus | 28,473 | 55,769 | -48.95 |
| Tzaneen | 79,637 | 135,977 | -41.43 |

Table 3‑2: Project Revenue Year to Date Overview

All plants have performed below forecasted revenue, with Durbanville and Hermanus showing the most significant deviation from forecast. Vergelegen has a misleading result due to the reconciliation of December 2022 production into January 2023 figures.

# Technical Portfolio Overview

We have investigated the performance of the Projects by comparing irradiance, availability, performance ratio, and production against forecasts. All sites have underperformed against the forecast. The underperformance of each site was dominated by frequent load shedding which results in curtailment. This curtailment occurs as the installed, grid-tied inverters have anti-islanding protection.

Anti-islanding protection is a necessary safety feature to protect grid workers by disabling the PV inverters when the grid experiences an outage – either planned or unplanned. In an islanded condition, the project could operate, generating power and supplying it to systems it is connected to and spilling excess back into the grid. Anti-islanding prevents this by disabling the inverters to prevent generation. In this way, anti-islanding ensures the safety of any person working on the disabled grid. Unfortunately, this system also means that the inverter will not operate during Eskom load shedding.

## Data Analysed

Harmattan compiled SCADA data and reviewed the January 2023 production reports for each site. Harmattan was provided with Operator data and note that no scheduled or unscheduled maintenance were reported in January 2023.

The performance data was directly downloaded from the Higeco SCADA System and processed using Microsoft Excel. However, the Operator stopped reporting irradiation to the SCADA system which had the effect of preventing PR calculation. As a result, Harmattan requested access to the irradiation data, which was available on Google Studio and used the PR from the Operator Production report. With this data, Harmattan calculated the weather-adjusted forecast for the plants.

# Highveld Technical Performance

The following chapter assesses the Project technical performance compared to forecast. We have evaluated irradiation, availability, performance ratio and production.

## System Design

The plant is a 258.9kWp system using 540 Wp JA Solar PV modules connected to 100 kW and 50 kW Huawei inverters with key details noted in Table 5‑1. The system uses PV modules to generate DC electricity that is converted to AC electricity by the inverters and used in the buildings. This offsets the grid supply during the times when solar electricity is available. The inverters installed by Mediclinic are grid tied with anti-islanding protection as explained in Chapter 5.

|  |  |
| --- | --- |
| Project Overview | |
| Design Capacity DC/AC (kW) | 263 / 250 |
| Installed Capacity DC/AC (kW) | 258.9 / 250 |
| Technology | Solar |
| Project Company | Moshesh Solar PV 1 (Pty) Ltd |
| Address | 46 Barney Molokwane, Trichardt South Africa |
| Commercial Operation Date | 30 March 2022 |

Table 5‑1: Highveld Project Overview

* 1. Irradiation Vs Forecast

Table 5‑1 shows the Project irradiance for Q1 2023 compared to the pre-construction Helioscope P50 prediction. Harmattan notes that the irradiance data is satellite-based.

|  |  |  |  |
| --- | --- | --- | --- |
| **Irradiation (kWh/m2)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 156 | 156 | -0.26 |
| May 23 | 118 | 155 | -24.13 |
| Jun 23 | 124 | 141 | -12.12 |
| **Total** | **398** | **453** | **-12.14** |

*Table 5‑2: Highveld Irradiation and Forecast.*

The actual irradiation was 398 kWh/m2, -12.14% lower than the forecasted irradiation of 453 kWh/m2. The below forecast irradiation in Q1 is due to poor irradiation experienced in March.

* 1. Availability Vs Forecast

The Operator has stated a minimum guaranteed availability of 99 % in their monthly reports. Harmattan has used this guaranteed availability to compare with the actual availability from the SCADA.

|  |  |  |  |
| --- | --- | --- | --- |
| **Availability (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 79 | 99 | -20.31 |
| May 23 | 70 | 99 | -28.92 |
| Jun 23 | 62 | 99 | -37.78 |
| **Total** | **70** | **99** | **-29.00** |

*Table 5‑3: Highveld Availability and Guaranteed*

Achieved availability was 70%, while the Guaranteed availability was 99%, resulting in a variance of -29.00%.

Availability is reduced by risks for which the Operator is not responsible. As an example, equipment failures affect availability, but Project switch offs due to force majeure would not. The full calculation methodology can be found in Appendix A1.

Possible factors that could have contributed to the low availability include unexpected downtime such as the high levels of load shedding, experienced by the Project. grid maintenance works, and normal faults. Load shedding is employer risk, but the Operator SCADA cannot distinguish between normal system loss, grid maintenance loss and loadshedding losses, the risk is on the Operator as they must prove that the system was down due to loadshedding. The availability does not reconcile load shedding and thus the Operator must manually record loadshedding. Furthermore, the Operator has stated that sometimes the power only goes off a little bit later and other times it's like clockwork. Additionally, the inverters take some time to start up, which also needs to be accounted for.

We recommend that the Operator improve data logging on the system as it is not clear from the SCADA when load shedding took place due to the unpredictability of loadshedding.

* 1. Performance Ratio Vs Forecast

Table 5‑4 shows the measured and forecast performance ratio (PR) of the Project.

|  |  |  |  |
| --- | --- | --- | --- |
| **Performance Ratio (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 93 | 90 | 3.06 |
| May 23 | 84 | 90 | -6.83 |
| Jun 23 | 72 | 90 | -20.02 |
| **Total** | **83** | **90** | **-7.93** |

*Table 5‑4: Highveld PR and Forecast*

In Q1 2023, the Performance Ratio was 83%, -7.93% higher than the forecasted value of 90%. PR The higher-than-expected performance ratio is due to the inclusion of December 2023 production into Q1 2023 data. This reconciliation was due to the meter connection error in December 2023.

* 1. Production Vs Forecast

Table 5‑5 shows the Q1 2023 actual production and comparisons to the original and weather adjusted forecasts.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Month** | **Production (kWh)** | | | **Actual vs Original Forecast (%)** | **Actual vs Weather Adjusted Forecast (%)** |
|  | **Original Forecast** | **Weather Adjusted Forecast** | **Actual Production** |
| Apr 23 | 31,598 | 31,517 | 26,125 | -17.32 | -17.11 |
| May 23 | 31,207 | 23,678 | 18,880 | -39.5 | -20.26 |
| Jun 23 | 28,479 | 25,029 | 22,215 | -22.0 | -11.24 |
| **Total** | **91,284** | **80,223** | **67,219** | **-26.36** | **-16.21** |

*Table 5‑5: Highveld Production and Forecast*

Production of 67,219 kWh was -26.36% below the original forecast of 91,284 kWh, and -16.21% below the weather-adjusted forecast. The low production in a period of low irradiance and low availability, likely reflects the curtailment due to load shedding and poor weather conditions.

# Durbanville Technical Performance

The following tables and figures describe the technical performance of the plant compared with the forecast. We have evaluated irradiation, availability, performance ratio and production.

## System Design

The plant is a 705.7kWp system consisting of 535Wp JA Solar PV modules connected to 13 Huawei 50 kW inverters with key details noted in Table 6 1. The inverters installed by Mediclinic are grid tied with anti-islanding protection as explained in Chapter 5

|  |  |
| --- | --- |
| Project Overview | |
| Design Capacity DC/AC (kW) | 704.6 / 650 |
| Achieved Capacity DC/AC (kW) | 705.7 / 650 |
| Technology | Solar |
| Project Company: | Moshesh Solar PV 1 (Pty) Ltd |
| Address: | Wellington Road Durbanville South Africa |
| Commercial Operation Date | 11 November 2022 |

Table 6‑1: Highveld Project Overview

* 1. Irradiation Vs Forecast

Table 6‑2 shows the Project irradiance for Q1 2023 compared to the pre-construction Helioscope P50 prediction. Harmattan notes that the irradiance data is satellite-based.

|  |  |  |  |
| --- | --- | --- | --- |
| **Irradiation (kWh/m2)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 123 | 157 | -21.3 |
| May 23 | 97 | 122 | -20.67 |
| Jun 23 | 57 | 103 | -45.19 |
| **Total** | **277** | **382** | **-27.54** |

*Table 6‑2: Durbanville Irradiation and forecast.*

The actual irradiation was 277 kWh/m2, -27.54% lower than the forecasted irradiation of 382 kWh/m2. The below forecast irradiation in Q1 is due to poor irradiation experienced in March.

* 1. Availability Vs Forecast

The Operator has stated a minimum guaranteed availability of 99 % in their monthly reports. Harmattan has used this guaranteed availability to compare with the actual availability from the SCADA.

|  |  |  |  |
| --- | --- | --- | --- |
| **Availability (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 83 | 99 | -15.91 |
| May 23 | 81 | 99 | -18.39 |
| Jun 23 | 77 | 99 | -21.75 |
| **Total** | **81** | **99** | **-18.68** |

*Table 6‑3: Durbanville Availability and Guaranteed*

Achieved availability was 81%, while the Guaranteed availability was 99%, resulting in a variance of -18.68%.

Availability is reduced by risks for which the Operator is not responsible. As an example, equipment failures affect availability, but Project switch offs due to force majeure would not. The full calculation methodology can be found in Appendix A1.

Possible factors that could have contributed to the low availability include unexpected downtime such as the high levels of load shedding, experienced by the Project. grid maintenance works, and normal faults. Load shedding is employer risk, but the Operator SCADA cannot distinguish between normal system loss, grid maintenance loss and loadshedding losses, the risk is on the Operator as they must prove that the system was down due to loadshedding. The availability does not reconcile load shedding and thus the Operator must manually record loadshedding. Furthermore, the Operator has stated that sometimes the power only goes off a little bit later and other times it's like clockwork. Additionally, the inverters take some time to start up, which also needs to be accounted for.

We recommend that the Operator improve data logging on the system as it is not clear from the SCADA when load shedding took place due to the unpredictability of loadshedding.

* 1. Performance Ratio Vs Forecast

Table 6‑4 shows the measured and forecast performance ratio (PR) of the Project.

|  |  |  |  |
| --- | --- | --- | --- |
| **Performance Ratio (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 59 | 90 | -34.64 |
| May 23 | 73 | 90 | -19.03 |
| Jun 23 | 62 | 90 | -31.0 |
| **Total** | **65** | **90** | **-28.23** |

*Table 6‑4: Durbanville PR and Forecast*

In Q1 2023, the Performance Ratio was 65%, -28.23% higher than the forecasted value of 90%. PR The higher-than-expected performance ratio is due to the inclusion of December 2023 production into Q1 2023 data. This reconciliation was due to the meter connection error in December 2023.

* 1. Production Vs Forecast

Table 6‑5 shows the Q1 2023 actual production and comparisons to the original and weather adjusted forecasts.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Month** | **Production (kWh)** | | | **Actual vs Original Forecast (%)** | **Actual vs Weather Adjusted Forecast (%)** |
|  | **Original Forecast** | **Weather Adjusted Forecast** | **Actual Production** |
| Apr 23 | 83,721 | 65,890 | 45,013 | -46.23 | -31.68 |
| May 23 | 66,691 | 52,907 | 43,179 | -35.26 | -18.39 |
| Jun 23 | 56,961 | 31,220 | 27,571 | -51.6 | -11.69 |
| **Total** | **207,373** | **150,017** | **115,763** | **-44.18** | **-22.83** |

*Table 6‑5: Durbanville Production and Forecast*

Production of 115,763 kWh was -44.18% below the original forecast of 207,373 kWh, and -22.83% below the weather-adjusted forecast. The low production in a period of low irradiance and low availability, likely reflects the curtailment due to load shedding and poor weather conditions.

# Midstream Technical Performance

The following tables and figures describe the technical performance of the plant compared with the forecast. We have evaluated irradiation, availability, performance ratio and production.

## System Design

The plant is a 227.9kWp system with 535Wp JA Solar PV module connected to 2 Huawei 100 kW inverters. with key details noted in Table 7‑1. The inverters installed by Mediclinic are grid tied with anti-islanding protection as explained in Chapter 5.

|  |  |
| --- | --- |
| Project Overview | |
| Design Capacity kW DC/AC (kW) | 227.9 / 200 |
| Achieved Capacity DC/AC (kW) | 227.9 / 220 |
| Technology | Solar |
| Project Company: | Moshesh Solar PV 1 (Pty) Ltd |
| Address: | Midstream Drive, Hill Boulevard Midstream Estate, Olifantsfontein. - South Africa |
| Commercial Operation Date | 27 October 2021 |

Table 7‑1:Midstream Project Overview

* 1. Irradiation Vs Forecast

Table 7‑2 shows the Project irradiance for Q1 2023 compared to the pre-construction Helioscope P50 prediction. Harmattan notes that the irradiance data is satellite-based.

|  |  |  |  |
| --- | --- | --- | --- |
| **Irradiation (kWh/m2)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 166 | 149 | 11.51 |
| May 23 | 124 | 142 | -12.25 |
| Jun 23 | 107 | 127 | -15.61 |
| **Total** | **398** | **418** | **-4.80** |

*Table 7‑2: Midstream Irradiation and forecast.*

The actual irradiation was 398 kWh/m2, -4.80% lower than the forecasted irradiation of 418 kWh/m2. The below forecast irradiation in Q1 is due to poor irradiation experienced in March.

* 1. Availability Vs Forecast

The Operator has stated a minimum guaranteed availability of 99 % in their monthly reports. Harmattan has used this guaranteed availability to compare with the actual availability from the SCADA.

|  |  |  |  |
| --- | --- | --- | --- |
| **Availability (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 73 | 99 | -26.15 |
| May 23 | 83 | 99 | -15.72 |
| Jun 23 | 75 | 99 | -24.19 |
| **Total** | **77** | **99** | **-22.02** |

*Table 7‑3: Midstream Availability and Guaranteed*

Achieved availability was 77%, while the Guaranteed availability was 99%, resulting in a variance of -22.02%.

Availability is reduced by risks for which the Operator is not responsible. As an example, equipment failures affect availability, but Project switch offs due to force majeure would not. The full calculation methodology can be found in Appendix A1.

Possible factors that could have contributed to the low availability include unexpected downtime such as the high levels of load shedding, experienced by the Project. grid maintenance works, and normal faults. Load shedding is employer risk, but the Operator SCADA cannot distinguish between normal system loss, grid maintenance loss and loadshedding losses, the risk is on the Operator as they must prove that the system was down due to loadshedding. The availability does not reconcile load shedding and thus the Operator must manually record loadshedding. Furthermore, the Operator has stated that sometimes the power only goes off a little bit later and other times it's like clockwork. Additionally, the inverters take some time to start up, which also needs to be accounted for.

We recommend that the Operator improve data logging on the system as it is not clear from the SCADA when load shedding took place due to the unpredictability of loadshedding.

* 1. Performance Ratio Vs Forecast

Table 7‑4 shows the measured and forecast performance ratio (PR) of the Project.

|  |  |  |  |
| --- | --- | --- | --- |
| **Performance Ratio (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 100 | 90 | 10.91 |
| May 23 | 80 | 90 | -11.14 |
| Jun 23 | 101 | 90 | 11.74 |
| **Total** | **93** | **90** | **3.84** |

*Table 7‑4: Midstream PR and Forecast*

In Q1 2023, the Performance Ratio was 93%, 3.84% higher than the forecasted value of 90%. PR The higher-than-expected performance ratio is due to the inclusion of December 2023 production into Q1 2023 data. This reconciliation was due to the meter connection error in December 2023.

* 1. Production Vs Forecast

Table 7‑5 shows the Q1 2023 actual production and comparisons to the original and weather adjusted forecasts.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Month** | **Production (kWh)** | | | **Actual vs Original Forecast (%)** | **Actual vs Weather Adjusted Forecast (%)** |
|  | **Original Forecast** | **Weather Adjusted Forecast** | **Actual Production** |
| Apr 23 | 26,473 | 29,519 | 24,686 | -6.75 | -16.37 |
| May 23 | 25,629 | 22,489 | 19,478 | -24.0 | -13.39 |
| Jun 23 | 23,232 | 19,606 | 17,603 | -24.23 | -10.22 |
| **Total** | **75,334** | **71,614** | **61,767** | **-18.01** | **-13.75** |

*Table 7‑5: Midstream Production and Forecast*

Production of 61,767 kWh was -18.01% below the original forecast of 75,334 kWh, and -13.75% below the weather-adjusted forecast. The low production in a period of low irradiance and low availability, likely reflects the curtailment due to load shedding and poor weather conditions.

# Hermanus Technical Performance

The following tables and figures describe the technical performance of the plant compared with the forecast. We have evaluated irradiation, availability, performance ratio and production.

## System Design

The plant is a 211.7kWp system with 540Wp JA Solar PV modules connected to two Huawei 100 kW with key details noted in Table 8‑1. The inverters installed by Mediclinic are grid tied with anti-islanding protection as explained in Chapter 5.

|  |  |
| --- | --- |
| Project Overview | |
| Design Capacity (kW) DC/AC: | 211.7 / 200 |
| Achieved Capacity (kW) DC/AC | 211.7 / 220 |
| Technology | Solar |
| Project Company: | Moshesh Solar PV 1 (Pty) Ltd |
| Address: | Ravenscroft Rd Hermanus – 7,200 – South Africa |
| Commercial Operation Date | 10 March 2022 |

* 1. Irradiation Vs Forecast

Table 8‑2 shows the Project irradiance for Q1 2023 compared to the pre-construction Helioscope P50 prediction. Harmattan notes that the irradiance data is satellite-based.

|  |  |  |  |
| --- | --- | --- | --- |
| **Irradiation (kWh/m2)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 130 | 135 | -4.04 |
| May 23 | 97 | 103 | -6.11 |
| Jun 23 | 68 | 85 | -19.49 |
| **Total** | **295** | **323** | **-8.76** |

*Table 8‑2: Hermanus Irradiation and forecast.*

The actual irradiation was 295 kWh/m2, -8.76% lower than the forecasted irradiation of 323 kWh/m2. The below forecast irradiation in Q1 is due to poor irradiation experienced in March.

* 1. Availability Vs Forecast

The Operator has stated a minimum guaranteed availability of 99 % in their monthly reports. Harmattan has used this guaranteed availability to compare with the actual availability from the SCADA.

|  |  |  |  |
| --- | --- | --- | --- |
| **Availability (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 61 | 99 | -38.26 |
| May 23 | 59 | 99 | -40.6 |
| Jun 23 | 48 | 99 | -51.97 |
| **Total** | **56** | **99** | **-43.61** |

*Table 9‑3: Vergelegen Availability and Guaranteed*

Achieved availability was 56%, while the Guaranteed availability was 99%, resulting in a variance of -43.61%.

Availability is reduced by risks for which the Operator is not responsible. As an example, equipment failures affect availability, but Project switch offs due to force majeure would not. The full calculation methodology can be found in Appendix A1.

Possible factors that could have contributed to the low availability include unexpected downtime such as the high levels of load shedding, experienced by the Project. grid maintenance works, and normal faults. Load shedding is employer risk, but the Operator SCADA cannot distinguish between normal system loss, grid maintenance loss and loadshedding losses, the risk is on the Operator as they must prove that the system was down due to loadshedding. The availability does not reconcile load shedding and thus the Operator must manually record loadshedding. Furthermore, the Operator has stated that sometimes the power only goes off a little bit later and other times it's like clockwork. Additionally, the inverters take some time to start up, which also needs to be accounted for.

We recommend that the Operator improve data logging on the system as it is not clear from the SCADA when load shedding took place due to the unpredictability of loadshedding.

* 1. Performance Ratio Vs Forecast

Table 8‑4 shows the measured and forecast performance ratio (PR) of the Project.

|  |  |  |  |
| --- | --- | --- | --- |
| **Performance Ratio (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 58 | 90 | -35.63 |
| May 23 | 54 | 90 | -39.49 |
| Jun 23 | 51 | 90 | -43.17 |
| **Total** | **55** | **90** | **-39.43** |

*Table 8‑4: Vergelegen PR and Forecast*

In Q1 2023, the Performance Ratio was 55%, -39.43% higher than the forecasted value of 90%. PR The higher-than-expected performance ratio is due to the inclusion of December 2023 production into Q1 2023 data. This reconciliation was due to the meter connection error in December 2023.

* 1. Production Vs Forecast

Table 8‑5 shows the Q1 2023 actual production and comparisons to the original and weather adjusted forecasts.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Month** | **Production (kWh)** | | | **Actual vs Original Forecast (%)** | **Actual vs Weather Adjusted Forecast (%)** |
|  | **Original Forecast** | **Weather Adjusted Forecast** | **Actual Production** |
| Apr 23 | 24,027 | 23,057 | 13,646 | -43.2 | -40.81 |
| May 23 | 18,384 | 17,260 | 10,157 | -44.75 | -41.15 |
| Jun 23 | 15,179 | 12,221 | 5,599 | -63.11 | -54.19 |
| **Total** | **57,590** | **52,538** | **29,402** | **-48.95** | **-44.04** |

*Table 8‑5: Vergelegen Production and Forecast*

Production of 29,402 kWh was -48.95% below the original forecast of 57,590 kWh, and -44.04% below the weather-adjusted forecast. The low production in a period of low irradiance and low availability, likely reflects the curtailment due to load shedding and poor weather conditions.

*.*

* 1. Availability Vs Forecast

The Operator has stated a minimum guaranteed availability of 99 % in their monthly reports. Harmattan has used this guaranteed availability to compare with the actual availability from the SCADA.

|  |  |  |  |
| --- | --- | --- | --- |
| **Availability (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 61 | 99 | -38.26 |
| May 23 | 59 | 99 | -40.6 |
| Jun 23 | 48 | 99 | -51.97 |
| **Total** | **56** | **99** | **-43.61** |

*Table 8‑3: Hermanus Availability and Guaranteed*

Achieved availability was 56%, while the Guaranteed availability was 99%, resulting in a variance of -43.61%.

Availability is reduced by risks for which the Operator is not responsible. As an example, equipment failures affect availability, but Project switch offs due to force majeure would not. The full calculation methodology can be found in Appendix A1.

Possible factors that could have contributed to the low availability include unexpected downtime such as the high levels of load shedding, experienced by the Project. grid maintenance works, and normal faults. Load shedding is employer risk, but the Operator SCADA cannot distinguish between normal system loss, grid maintenance loss and loadshedding losses, the risk is on the Operator as they must prove that the system was down due to loadshedding. The availability does not reconcile load shedding and thus the Operator must manually record loadshedding. Furthermore, the Operator has stated that sometimes the power only goes off a little bit later and other times it's like clockwork. Additionally, the inverters take some time to start up, which also needs to be accounted for.

We recommend that the Operator improve data logging on the system as it is not clear from the SCADA when load shedding took place due to the unpredictability of loadshedding.

* 1. Performance Ratio Vs Forecast

Table 9‑4 shows the measured and forecast performance ratio (PR) of the Project.

|  |  |  |  |
| --- | --- | --- | --- |
| **Performance Ratio (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 58 | 90 | -35.63 |
| May 23 | 54 | 90 | -39.49 |
| Jun 23 | 51 | 90 | -43.17 |
| **Total** | **55** | **90** | **-39.43** |

*Table 8‑4: Hermanus PR and Forecast*

In Q1 2023, the Performance Ratio was 55%, -39.43% higher than the forecasted value of 90%. PR The higher-than-expected performance ratio is due to the inclusion of December 2023 production into Q1 2023 data. This reconciliation was due to the meter connection error in December 2023.

* 1. Production Vs Forecast

Table 9 5 shows the Q1 2023 actual production and comparisons to the original and weather adjusted forecasts.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Month** | **Production (kWh)** | | | **Actual vs Original Forecast (%)** | **Actual vs Weather Adjusted Forecast (%)** |
|  | **Original Forecast** | **Weather Adjusted Forecast** | **Actual Production** |
| Apr 23 | 24,027 | 23,057 | 13,646 | -43.2 | -40.81 |
| May 23 | 18,384 | 17,260 | 10,157 | -44.75 | -41.15 |
| Jun 23 | 15,179 | 12,221 | 5,599 | -63.11 | -54.19 |
| **Total** | **57,590** | **52,538** | **29,402** | **-48.95** | **-44.04** |

*Table 8‑5: Hermanus Production and Forecast*

Production of 29,402 kWh was -48.95% below the original forecast of 57,590 kWh, and -44.04% below the weather-adjusted forecast. The low production in a period of low irradiance and low availability, likely reflects the curtailment due to load shedding and poor weather conditions.

# Vergelegen Technical Performance

The following tables and figures describe the technical performance of the plant compared with the forecast. We have evaluated irradiation, availability, performance ratio and production.

## System Design

The system is a 689.6kWp project with 535Wp JA Solar PV modules connected to six Huawei 100 kW inverters and one Huawei 50 kW inverter with key details noted in Table 9‑1. The inverters installed by Mediclinic are grid tied with anti-islanding protection as explained in Chapter 5.

|  |  |
| --- | --- |
| Project Overview | |
| Design Capacity DC/AC (kW) | 697.1 / 650 |
| Achieved Capacity DC/AC (kW) | 689.6 / 650 |
| Technology | Solar |
| Project Company: | Moshesh Solar PV 1 (Pty) Ltd |
| Address: | Vergelegen, Main Road Somerset West South Africa |
| Commercial Operation Date | 28 Oct 2022 |

Table 9‑1: Vergelegen Project Overview

* 1. Irradiation Vs Forecast

Table 9 2 shows the Project irradiance for Q1 2023 compared to the pre-construction Helioscope P50 prediction. Harmattan notes that the irradiance data is satellite-based.

|  |  |  |  |
| --- | --- | --- | --- |
| **Irradiation (kWh/m2)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 120 | 127 | -5.78 |
| May 23 | 95 | 91 | 4.07 |
| Jun 23 | 54 | 73 | -26.94 |
| **Total** | **268** | **291** | **-8.04** |

*Table 9‑2: Vergelegen Irradiation and forecast.*

The actual irradiation was 268 kWh/m2, -8.04% lower than the forecasted irradiation of 291 kWh/m2. The below forecast irradiation in Q1 is due to poor irradiation experienced in March.

* 1. Availability Vs Forecast

The Operator has stated a minimum guaranteed availability of 99 % in their monthly reports. Harmattan has used this guaranteed availability to compare with the actual availability from the SCADA.

|  |  |  |  |
| --- | --- | --- | --- |
| **Availability (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 74 | 99 | -25.63 |
| May 23 | 81 | 99 | -17.8 |
| Jun 23 | 0 | 99 | -100.0 |
| **Total** | **52** | **99** | **-47.81** |

*Table 9‑3:* *Vergelegen Availability and Guaranteed*

Achieved availability was 52%, while the Guaranteed availability was 99%, resulting in a variance of -47.81%.

Availability is reduced by risks for which the Operator is not responsible. As an example, equipment failures affect availability, but Project switch offs due to force majeure would not. The full calculation methodology can be found in Appendix A1.

Possible factors that could have contributed to the low availability include unexpected downtime such as the high levels of load shedding, experienced by the Project. grid maintenance works, and normal faults. Load shedding is employer risk, but the Operator SCADA cannot distinguish between normal system loss, grid maintenance loss and loadshedding losses, the risk is on the Operator as they must prove that the system was down due to loadshedding. The availability does not reconcile load shedding and thus the Operator must manually record loadshedding. Furthermore, the Operator has stated that sometimes the power only goes off a little bit later and other times it's like clockwork. Additionally, the inverters take some time to start up, which also needs to be accounted for.

We recommend that the Operator improve data logging on the system as it is not clear from the SCADA when load shedding took place due to the unpredictability of loadshedding.

* 1. Performance Ratio Vs Forecast

Table 9‑4 shows the measured and forecast performance ratio (PR) of the Project.

|  |  |  |  |
| --- | --- | --- | --- |
| **Performance Ratio (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 86 | 90 | -4.59 |
| May 23 | 80 | 90 | -11.43 |
| Jun 23 | 69 | 90 | -22.82 |
| **Total** | **78** | **90** | **-12.95** |

*Table 9‑4: Vergelegen PR and Forecast*

In Q1 2023, the Performance Ratio was 78%, -12.95% higher than the forecasted value of 90%. PR The higher-than-expected performance ratio is due to the inclusion of December 2023 production into Q1 2023 data. This reconciliation was due to the meter connection error in December 2023.

* 1. Production Vs Forecast

Table 9 5 shows the Q1 2023 actual production and comparisons to the original and weather adjusted forecasts..

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Month** | **Production (kWh)** | | | **Actual vs Original Forecast (%)** | **Actual vs Weather Adjusted Forecast (%)** |
|  | **Original Forecast** | **Weather Adjusted Forecast** | **Actual Production** |
| Apr 23 | 69,138 | 65,140 | 56,657 | -18.05 | -13.02 |
| May 23 | 50,287 | 52,335 | 42,760 | -14.97 | -18.3 |
| Jun 23 | 40,932 | 29,904 | 20,563 | -49.76 | -31.24 |
| **Total** | **160,357** | **147,379** | **119,980** | **-25.18** | **-18.59** |

*Table 9‑5: Vergelegen Production and Forecast*

Production of 119,980 kWh was -25.18% below the original forecast of 160,357 kWh, and -18.59% below the weather-adjusted forecast. The low production in a period of low irradiance and low availability, likely reflects the curtailment due to load shedding and poor weather conditions.

# Tzaneen Technical Performance

The following tables and figures describe the technical performance of the plant compared with the forecast. We have evaluated irradiation, availability, performance ratio and production.

## System Design

The project is a 405kWp system with 540Wp JA Solar PV modules connected to four Huawei 100 kW inverters with key details noted in Table 10‑1. The inverters installed by Mediclinic are grid tied with anti-islanding protection as explained in Chapter 5.

|  |  |
| --- | --- |
| Project Overview | |
| Design Capacity DC/AC (kW) | 405 / 400 |
| Achieved Capacity DC/AC (kW) | 405 / 350 |
| Technology | Solar |
| Project Company: | Moshesh Solar PV 1 (Pty) Ltd |
| Address: | Tzaneen, Main Road Somerset West South Africa |
| Commercial Operation Date | 11 Oct 2022 |

Table 10‑1: Tzaneen Project Overview

* 1. Irradiation Vs Forecast

Table 9 2 shows the Project irradiance for Q1 2023 compared to the pre-construction Helioscope P50 prediction. Harmattan notes that the irradiance data is satellite-based.

|  |  |  |  |
| --- | --- | --- | --- |
| **Irradiation (kWh/m2)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 150 | 149 | 1.04 |
| May 23 | 114 | 144 | -20.7 |
| Jun 23 | 125 | 128 | -1.99 |
| **Total** | **389** | **420** | **-7.32** |

*Table 9‑2: Tzaneen Irradiation and forecast.*

The actual irradiation was 389 kWh/m2, -7.32% lower than the forecasted irradiation of 420 kWh/m2. The below forecast irradiation in Q1 is due to poor irradiation experienced in March.

* 1. Availability Vs Forecast

The Operator has stated a minimum guaranteed availability of 99 % in their monthly reports. Harmattan has used this guaranteed availability to compare with the actual availability from the SCADA.

|  |  |  |  |
| --- | --- | --- | --- |
| **Availability (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 0 | 99 | -100.0 |
| May 23 | 0 | 99 | -100.0 |
| Jun 23 | 0 | 99 | -100.0 |
| **Total** | **0** | **99** | **-100.00** |

*Table 10‑3: Tzaneen Availability and Guaranteed*

Achieved availability was 0%, while the Guaranteed availability was 99%, resulting in a variance of -100.00%.

Availability is reduced by risks for which the Operator is not responsible. As an example, equipment failures affect availability, but Project switch offs due to force majeure would not. The full calculation methodology can be found in Appendix A1.

Possible factors that could have contributed to the low availability include unexpected downtime such as the high levels of load shedding, experienced by the Project. grid maintenance works, and normal faults. Load shedding is employer risk, but the Operator SCADA cannot distinguish between normal system loss, grid maintenance loss and loadshedding losses, the risk is on the Operator as they must prove that the system was down due to loadshedding. The availability does not reconcile load shedding and thus the Operator must manually record loadshedding. Furthermore, the Operator has stated that sometimes the power only goes off a little bit later and other times it's like clockwork. Additionally, the inverters take some time to start up, which also needs to be accounted for.

We recommend that the Operator improve data logging on the system as it is not clear from the SCADA when load shedding took place due to the unpredictability of loadshedding.

* 1. Performance Ratio Vs Forecast

Table 9‑4 shows the measured and forecast performance ratio (PR) of the Project.

|  |  |  |  |
| --- | --- | --- | --- |
| **Performance Ratio (%)** | | | |
| **Month** | **Actual** | **Forecast** | **Delta (%)** |
| Apr 23 | 66 | 90 | -26.18 |
| May 23 | 62 | 90 | -31.43 |
| Jun 23 | 72 | 90 | -20.0 |
| **Total** | **67** | **90** | **-25.87** |

*Table 10‑4: Tzaneen PR and Forecast*

In Q1 2023, the Performance Ratio was 67%, -25.87% higher than the forecasted value of 90%. PR The higher-than-expected performance ratio is due to the inclusion of December 2023 production into Q1 2023 data. This reconciliation was due to the meter connection error in December 2023.

* 1. Production Vs Forecast

Table 9 5 shows the Q1 2023 actual production and comparisons to the original and weather adjusted forecasts..

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Month** | **Production (kWh)** | | | **Actual vs Original Forecast (%)** | **Actual vs Weather Adjusted Forecast (%)** |
|  | **Original Forecast** | **Weather Adjusted Forecast** | **Actual Production** |
| Apr 23 | 51,550 | 52,084 | 32,577 | -36.8 | -37.45 |
| May 23 | 51,209 | 40,608 | 23,243 | -54.61 | -42.76 |
| Jun 23 | 46,272 | 45,350 | 31,461 | -32.01 | -30.63 |
| **Total** | **149,031** | **138,041** | **87,282** | **-41.43** | **-36.77** |

*Table 10‑5: Tzaneen Production and Forecast*

Production of 87,282 kWh was -41.43% below the original forecast of 149,031 kWh, and -36.77% below the weather-adjusted forecast. The low production in a period of low irradiance and low availability, likely reflects the curtailment due to load shedding and poor weather conditions.

# Events

## Health and Safety

No health and safety incidences were reported by the Operator based on the information provided by the Operator.

## Scheduled Maintenance

No other maintenance activities except for monitoring (SCADA) and documentation were performed in January 2023 based on the information provided by the Operator. We note that no annual plan was provided by the Operator for each plant. Harmattan recommends that the Operator provides an annual operational plan to verify if tasks are on performed on specific dates.

## Unscheduled Maintenance

Harmattan has reviewed the data room provided by the Operator and noted that no unscheduled maintenance was reported in January for all the plants.

## Spare Parts

Harmattan notes that no spare parts are kept parts on site by ACES. The Operator has stated that minor spare parts are in stock in Cape Town and Johannesburg. Major spares will be kept in Cape Town by the Operator. We note that only keeping the major spare parts in Cape Town may present a problem for plants outside of Cape Town given the longer lead times to deliver the spare to site, resulting in higher production losses

# Documents Reviewed

|  |  |
| --- | --- |
| Project Name | Documents Reviewed |
| Vergelegen | * Vergelegen DS Jan 2023 * Mediclinic DS January 2023 All Sites |
| Durbanville | * Durbanville DS Jan 2023 * Mediclinic DS January 2023 All Sites |
| Midstream | * Midstream DS Jan 2023 * Mediclinic DS January 2023 All Sites |
| Hermanus | * Hermanus DS Jan 2023 * Mediclinic DS January 2023 All Sites |
| Highveld | * Highveld DS Jan 2023 * Mediclinic DS January 2023 All Sites |

Table 12‑1: Document Reviewed

A1. Appendix Availability Guaranteed

